

## **SPECIFICATION**

### **TO WHOM IT MAY CONCERN**

**BE IT KNOWN, That I Robert A. Hansen, a citizen of the United States, residing in Oakdale, Washington County, State of Minnesota, have invented new and useful improvements in LIMIT SWITCH of which the following is a specification.**

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**FIELD OF THE INVENTION**

This invention relates to a limit switch and, more particularly, to a field serviceable limit switch that can provide an operator with information on the condition of a component or system such as on a pneumatic conveying system.

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**CROSS REFERENCE TO RELATED APPLICATIONS**

None

**STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR  
DEVELOPMENT**

15    None

**REFERENCE TO A MICROFICHE APPENDIX**

None

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**BACKGROUND OF THE INVENTION**

The concept of limit switches for indication of the status of a component is generally known in the art. In general, indicators with electrical switches and cam members are packaged as a unit. When the limit switch malfunctions in the field one has to replace the entire limit switch. As the replacement can be time consuming as well as costly it is  
25    desirable to eliminate the system down time as well as the cost to replace an entire limit switch.

The present invention provides a field serviceable limit switch that includes a status indicator that visually alerts an observer to the condition of a particular component or components of a system such as a valve or the like in a pneumatic conveying system. The limit switch can also be used to control various other components in the pneumatic system  
5 as well as to indicate the presence of a faulty or dangerous condition in a system such as in a pneumatic conveying system.

Typically, the field serviceable limit switch can include such items as field replaceable electrical switches, field replaceable terminal blocks, field replaceable cams and field  
10 replaceable cam holders, field replaceable transducers, field replaceable indicators and a field replaceable transparent housing. By field replaceable part it is meant that an individual part can be quickly replaced by an operator in the field with few or no hand tools and without the need to replace the entire limit switch.

## 15 SUMMARY OF THE INVENTION

Briefly, the present invention comprises a limit switch having a housing carrying one or more components that are individually field replaceable by an operator so that an operator can make an on-the-go field repair any faulty component in the limit switch. The field replaceable components can be frictionally or mechanically secured by a finger operable  
20 latch or the like so that an operator can remove and quickly replace a faulty component while the limit switch is connected a pneumatic conveying system or the like.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an exploded view of the limit switch with an alerter;

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Figure 2 is a side view of the limit switch in an assembled condition; and

Figure 3 is a partial side view of the of the cam with the cam rollers on electrical switches carried in the housing of the limit switch.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

5 Figure 1 shows an exploded view of a limit switch 10. Limit switch 10 includes a base 11 for securing to a mount or the like. Base 11 carries a square shaped housing 12 having a chamber 13 therein. Housing 12 contains a set of snap latches 12a located on opposite sides for releasable securing a cover 65 thereto. Each of snap latches 12a include a fastener 12c for securing the snap latch 12a to the housing 12. Located around the top peripheral  
10 region of housing 12 is a lip 12b that forms a shoulder for supporting cover 65 thereon. Base 11, housing 12 and cover 65 are preferable made from a polymer plastic or the like.

Located within the housing 12 are a number of replaceable components that are releasably secured to permit field replacement of the limit switch components thus avoiding the need  
15 to replace an entire limit switch if one component fails.

Limit switch 10 includes an alerter or visual indicator 60 to provide an observer a status indication of the equipment being monitored. For example, the limit switch might be used to indicate whether a valve is in an open or closed condition as well as to control other  
20 components in a system such as a pneumatic conveying system.

Figure 1 shows a centrally positioned cam shaft 40 rotationally supported in housing 12. Located on cam shaft 40 is a cam latch 40a for removably securing a cam 55 thereon. Cam 55 includes a cross shaped slot 55a for mechanical engagement with cam shaft 40 to permit  
25 the cam shaft 55 to rotate the cam 55. Located on one side of cam 55 is a cam lobe 55b and on the other side is a cam lobe 55c. In assembly of cam shaft 40 and cam 55 the cam 55 is slid longitudinally downward along shaft 40, which forces the cantilevered resilient latch

40a to cantilever inward and allow cam 55 to slide therepast. Once the cam 55 is past the cam latch 40a the resilient cam latch 40a snaps outward to prevent withdrawal of the cam 55 from the cam shaft 40a. To remove and replace cam 55 one can squeeze cam latch 40a toward cam 40 thus allowing cam 55 to be slide upward and off the cam shaft 40.

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The lower end of cam shaft 40 includes an end 40b for engaging with a device that connects to the system being monitored. For example, cam shaft end 40b can be connected to the pivot member on a butterfly type valve in a pneumatic conveying system to cause the cam shaft 40 to rotate as the butterfly valve is opened or closed. The top end 40c of cam shaft 40 engages a dome shaped visual indicator 60. Dome shape indicator 60 includes a female receptacle (not shown) that mechanically connects to cam shaft 40 to cause the indicator 60 to rotate as the cam shaft 40 rotates. The dome shaped indicator 60 includes a first peripheral region 60a with a first readable visual message such as "CLOSED" and a second peripheral region 60b with a second readable visual message such as "OPEN".

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In order for a person to obtain the information on the system or component status a masking cover 70 is provided that includes a first peripheral opening 70a that permits viewing one or the other of the readable message 60a and 60b therethrough. That is, on one condition the "OPEN" message can be visible through peripheral region 70a to let the operator know that the component being monitored is in an open condition. Similarly, in another condition the "CLOSED" message can be visible through opening 70a to let the observer know the component is in a closed condition.

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Indicator 60 provides dual signals or dual visual indicators, one that is visible in a lateral direction from the limit switch and one that is visible from above the limit switch. The second visual indicator comprises a color coded regions 60c which comprises truncated pie shaped segments on the top surface of indicator 60. For example, regions 60c can be

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colored red so as to indicate that a component being monitored is in a closed condition.

Spaced adjacent to color coded peripheral region 60c are two additional truncated pie shaped colored regions 60d. Regions 60d can be color coded green to indicate the monitored component is in the open condition.

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Located on top of indicator drum 60 is masking cover 70 that includes a first truncated pie shaped opening 70c and a second diagonally positioned truncated pie shaped opening 70b.

In operation of the limit switch 10 the color coded regions 60c or 60d are visible through the truncated pie shape openings 70b and 70c. For example, in one condition color coded

10 regions 60c, which may be red to indicate a closed condition, are visible through; the openings 70b and 70c to indicate the component is in a closed condition. In another condition the color coded regions 60d, which can be green to indicate an open condition, are visible through the openings 70c and 70b to indicate the component is in an open condition.

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The use of a solid color coded region also provides a proportional signal. That is, if a portion of the red coded region 60c and a portion of the green coded region 60d are visible in the opening 70c and 70b one can determine the condition of the component. For

example, one could determine that the component being monitored, such as a butterfly

20 valve, is in a 50% open condition by observing that half of the green colored region 60d is visible and half of the red colored region 60c is visible through the openings 70b and 70c.

In order to protect the indicator 60 from the environmental conditions there is provided a cup shaped transparent member 75 that fits over the masking cover 70 and the visible

25 indicator 60 to permit an observer to observe the visual signals from the indicator 60 from either a lateral position with respect to the limit switch 10 or a position above the limit switch 10.

Figure 2 shows the transparent member 75 and masking cover 70 can be secured directly to the top of cover 65 along the circumferential edge 65a on cover 65. This allows one to assemble the cover 65 and transparent member 75 as a unit to the housing 12. A set of four  
5 identical tabs 65b located on opposite sides (only two are shown) allow one to use snap latches 12a to secure the cover 65 to the unit to form a closed and protected limit switch with alerter (see Figure 1) . Thus a person positioned laterally of limit switch 10 can view the indicator 60 thorough the peripheral opening 70a in masking cover 70.

10 The cam shaft 40a and indicator 60 in cooperation with cover 65, housing 12 and transparent cover 75 can provide a visual indication of the status of a component through the rotational displacement of the cam shaft 40. A further feature of the invention is that the cam shaft 40 can be used to control an electrical circuit. In order to appreciate the control of an electrical circuit reference should be made to Figure 1, which shows a switch holder 30  
15 comprising a box like member extending upwardly in the housing 12. Switch holder 30 contains a chamber 30a for receiving a first electrical switch 31 having a cantilevered roller arm 31a and second electrical switch having a cantilevered rolling arm 33b. Such switches are well known in the art and are readily available as off-the-shelf items. The switches have two conditions, an off condition and an on condition. In one type of switch the off  
20 condition occurs when the roller arm is depressed and in another type of switch the on condition occurs when the roller arm is depressed. Each of the switches 31 and 32 are peripherally held in position by the sidewalls of the box like switch holder 30 so that no screws or the like are required to secure the switches in an operating condition proximate cam 55.

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Figure 3 shows an isolated view of the switch holder 30 and the cam 55 in engagement with each other. In this embodiment two switches 31 and 33 are removably secured in

switch holder 30 by a cover 30a having a lip or latch 30b that engages switch holder 30 to secure the switches 31 and 33 in a fixed condition in switch holder 30. In this condition the cantilevered resiliently mounted roller arms 31a and 33b protrude outward from switch holder 30 and are in an operable position to engage the cam 55. In the position shown a  
5 cylindrical cam surface 55c is in contact engagement with roller arm 33b and the cam lobe 55 is in contact engagement with roller arm 31a. Additional cam lobes 55d and 55e provide for additional contact with the roller arms. As cam shaft 40 rotates the different cam lobes 55d and 55e are brought into contact with the roller arms on the switches 31 and 33 to bring the switches 31 and 33 to proper on or off condition. Thus, a feature of the invention  
10 is that a conventional electrical switch can be quickly inserted or removed from switch holder 30 by merely engaging or disengaging snap latch cover 30a which includes ears for engaging the peripheral lip extensions 30d on switch holder 30. In the embodiment shown switch holder 30 includes a base 30e that can be secured to extension 12e in housing 12 to allow for removal and replacement with few or no hand tools. (See Figure 1)

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A further feature of the invention is the inclusion of an electrical terminal block holder 20 which is shown in Figure 1. Terminal block holder 30 comprises a frame like member having a set of cylindrical pegs 20c that extend upward. The lower portion of block holder 20 includes an extension 20a for frictionally engaging extension 12f in housing 12 to hold  
20 electrical terminal block holder 20 thereon. Once the terminal block holder 30 is secured to housing 12 the terminal block 25 is positioned on the cylindrical pegs 20c to prevent lateral movement thereon. The side member 20b of block holder 20 comprises a resilient member having a lip (not shown) that latchingly engages one end of the terminal block 25 to hold one end of the terminal block in position in housing 12. An identical side member (not  
25 shown) is located on the opposite end of block holder 20 to hold the opposite end of the terminal block 25 in position.



An interface device 15, which can be a transducer or the like that relates a pneumatic condition to an electrical condition, can be secured to housing 12 through an extension 15a to enable a pressure signal to be transferred through connection 12c to transducer 15 though the sidewall of housing 12. The interface device 15 includes a set of electrical leads 5 15b for connection to the electrical terminal block 25. The electrical leads are omitted for purposes of clarity, but in operation the electrical leads 15b can extend from the interface device 15 to the terminal block 25 and from the terminal block 25 to the connector lugs (not shown) on the electrical switches 31 and 33. Thus a further feature of the invention is that the terminal block is removably mounted in housing 12 and can be replaced as well as the 10 terminal holder 20. In addition, the chamber 13 in housing 12 can carry both electrical components as well as mechanical components with either or both of the electrical and mechanical components field replaceable.

A further feature of the invention is that extending partially around cam shaft 40 and 15 extending vertically upward is a wire guard 50 that is fixedly supported in housing 12. Wire guard 50 extends upward and circumferentially to prevent wires in housing 12 from being accidentally caught by the rotating cam shaft 40b.

In operation of the limit switch an operator can quickly open the limit switch by releasing 20 the latch 12a to allow removal of the cover 65. Once the cover 65 is removed the operator can obtain access to the components that are held in the housing 12. An operator can then quickly replace the faulty component and replace the cover thus allowing the system to be up and running with a minimum of delay.